Review of *Linear Algebra and Its Application, Volume 1: A First Course* and *Linear Algebra and Its Application, Volume 2: More Advanced* by D. H. Griffel*

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This two volume set of texts is designed to provide material for a course of up to one full year at the undergraduate level. It requires as a prerequisite some knowledge of calculus and complex numbers, but little mathematical sophistication.

The progression of these books is not the usual one. Volume 1 consists of eight chapters and eight appendices. The chapters, in order, are titled: Elementary Vector Spaces; Matrices; Vector Spaces; Elementary Operations and Linear Equations; Linear Transformations on Vector Spaces; Determinants; Eigenvalue Problems and the Characteristic Equation; and Diagonalisation of Matrices and Quadratic Forms.

Chapter 1 gives the theory of vector spaces in the two and three dimensional Euclidean setting, while Chapter 3 gives it in a general setting. Gaussian elimination is not introduced until Chapter 4, and the treatment is appropriate for postcalculus level instruction. While Chapter 7 is entitled Eigenvalue Problems and the Characteristic Equation, eigenvalues and eigenvectors are actually introduced in Chapter 5 in the context of linear transformations. The appendices include discussions of how to read

* Wiley, 1989.

655 Avenue of the Americas, New York, NY 10010 0024-3795/92/$5.00

mathematics, mathematical induction, sets, functions, complex numbers, polynomials, and fields. Also in the appendices is an historical account of the development of linear algebra beginning 486 A.D. The appendix on how to read mathematics is enjoyable and should be required reading for every mathematics course beyond freshman level algebra.

The chapters in Volume 2 are titled: Matrix Representation of Linear Transformations; Similarity and Diagonalisation; Inner Product Spaces; Self Adjoint Operators; Least Squares, the Pseudo-inverse, and Related Matters; and Duality and Its Applications. Volume 2 has one appendix on closed sets.

Throughout the chapters are sections which are marked by an asterisk and are intended to be supplements to a basic course. Some of these optional sections are devoted to classical problems, such as the section in Chapter 5 on eigenvalues and vibrating systems, and the section on quantum mechanics in Chapter 12. Other optional sections cover subjects less commonly found in linear algebra texts, such as the section in Chapter 3 on the theory of color vision, relating color vision to a three dimensional vector space and color blindness to a one or two dimensional subspace, and the section in Chapter 9 about the application of vector spaces over finite fields to error correcting codes. Still other optional sections are devoted to further theory, such as the section in Chapter 7 on Gershgorin's theorem. Algorithms of numerical linear algebra such as *LDU* decomposition, the power method, and the *QR* algorithm are all to be found in optional sections. While most of the content of the appendices is prerequisite to the basic course, knowledge of finite fields is needed only for optional sections. Appropriate to a modern text at this level, the adjunct or adjoint matrix is discussed in an optional section, and Cramer's rule is not mentioned.

A student who completes the basic course should gain a great deal of mathematical sophistication. Thus, with or without the optional sections, this text could well be used for mathematics majors as well as for applied science and engineering majors. The pace and sophistication begin at rates appropriate to a first course in linear algebra with a calculus prerequisite; but, unlike most elementary linear algebra texts, the level of difficulty does not rise significantly. Reading the text requires some elementary mathematical logic from beginning to end.

Exercises are embedded in the text, with solutions for all following the appendices. At the end of each chapter are problem sets, divided into problems appropriate to each section of the chapter. At the rear of each volume are hints and solutions to selected problems.

The text is both mathematically rigorous and enjoyable to read, making it suitable for the classroom and for directed study. The author answers many questions one hopes students would ask. He gives delightful explanations of zero vectors and the associative law, for example.

The list price is $49.95 per volume, so that the two volume price is significantly more than the average price of a single volume text covering the same material at the same level. The only other negative aspect, and it is tied to the first, is that many one quarter or one semester linear algebra courses include matrix representation and change of basis topics, a discussion of the Gram-Schmidt algorithm, or the study of least squares approximation, which are in Volume 2, thus requiring the purchase of both volumes if covering these topics is essential.

Received 23 January 1991; final manuscript accepted 24 January 1991